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Daylighting Control System for LED Based Energy-Efficient Lighting Systems

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Abstract:

The proposed system presents a simulation environment and daylighting control approach to achieve energy-efficient lighting system and providing desired lighting levels at the purpose points. The lighting system procedure is based on a self-tuning multivariable controller, which controls the illuminance levels such as maximum or minimum at user-defined set-points, while reducing the energy consumption as compared to the traditional lighting system. Now a day saving energy has become one of the most significant points. Particularly, a light account for a great part of the total energy consumption. Now a day market can be introduced various light control systems because the currently installed lighting systems are old and energy-inefficient. However, due to structural limitations, the existing light control systems cannot be successfully involved to home and office buildings. Hence, recommends of new intelligent household LED lighting system considering energy productivity and user comfort. The recommended LED lighting system can autonomously adjust the minimum light intensity value to enhance both energy productivity and user comfort. The recommended LED lighting system decreases total power consumption. The technology of Power over Ethernet can take sufficient electricity to LED lighting system. Depending on the understanding knowledge of the current illumination and the whole persons in a room, the system can automatically distinguish and utilize a predefined brightness. Therefore, it overcomes the limitations of a traditional light control system. At the same time system can transfers DC power and data through Ethernet, reduce the power adapter failure which caused by data network failure and promotes the application of the low power network equipment.

Keywords: LED lighting system, reducing the minimum light intensity control algorithm, control on situation awareness, POE Module

1. Introduction

India nation can be demanded a large amount of in electricity demand then it can be certain required energy saving lighting systems. The lighting system can be consumption electricity load in our nation is very high about 20-22% of whole electricity load. By improving the efficiency of lighting system then it can be required vital energy saving and reducing in a peak load lighting system. Then it can be necessary required the lighting system which can be overcome the electricity demand up to 25% to 30 % of the morning and evening peak demand.

Now a day building lighting system can be required to satisfy the dual aim of maximum occupant comfort and minimum energy consumption. When certainly recommended system can be successfully realized then it is suitable for the environmental policy brings to develop both capacity building within a nation's human resources and environmental awareness within the community. Energy conservation solution in buildings not only saves the money but also helps to preserve the ecosystem and natural resources. Now a day user can be used large quality of lighting systems such as day lighting control and LED which can be used some new methodologies which are useful for reducing the and energy impact on environment and future generations.

Now a day various embedded lighting system can be introduced which can be adjust the lighting levels automatically according to the time of day, function of space, available light level. The proposed system of new intelligent lighting system can be control automatically, such as, occupancy sensors, dimming, lighting control panels, and Building Management Systems. To save the energy became increasingly essential in the recent year because environment problem such as global warming and climate change. Environmental problems are very important aspect in these days, these environment problems are largely introduced by the unnecessary use of energy.

A lighting system can be utilized for around 20 percent of the world's overall whole energy consumption. The new implementation of a light emitting diode (LED) is significantly reduced the energy consumption of a light, because the LED lighting system can be utilized 50 percent of the energy consumption as compared to the incandescent lighting device (high-pressure sodium) and fluorescent lighting device (low-pressure sodium).

Recently, new intelligent lighting control system can be used various sensors and communication modules such as PIR sensor and illumination sensor. The PIR sensor can be detect the human interaction in the room and automatically adjust the room light intensity according to user movement. The illumination sensor can be working according to external environmental changes such as when room outside brightness is high then illumination sensor has high resistance and it can be adjusted the low brightness in the internal side of the room. When room outside brightness is low then illumination sensor has low resistance and it can be adjusted the high brightness in the internal side of the room. Means it can be adjust room light intensity according to external environmental changes.

However, the traditional lighting control systems can support for only dimming control or simple on-off according to user movement or brightness of surroundings but this lighting system is hard to applicable for the complex environments such as house or office. Thus the complex environment means it can be required a variety of control because of the presence of a variety of users.

When proposed system can be designed by using any processor it cannot be used PoE module because PoE module cannot support any other controller, it can be supported only for an Arduino controller. Because of this reason when another controller can be connected any sensor it can be required external power supply, this controller cannot provide any internal power supply but these recommended systems can be used Arduino with PoE module, when PoE module can be connected to the Ethernet board and can be connected any sensor then it cannot be required any external power supply because PoE can provide the internal power supply of any sensor module. Hence by using the PoE module power consumption can be reduced.

In The Recommended System design the Domestic such as house and commercial such as industrial LED Lighting System considering low power consumption with an illumination sensor, motion detection sensor and wireless communication interface.

By examining all these things, design proposed of the new intelligent LED lighting control system is as follows:

- Proposed system can be Design to control based on the situation awareness and adjust the brightness of LED light inside the room.
- Proposed system can be Design Autonomous control based on user movement and simply ON-OFF LED lights.
- Proposed system can be Design to maximum the utilization of a LED.
- Recommended system can be Design to have the communication capability.
- Reduction in power consumption and Saves energy.
- Improves the life of devices.
- Proposed system can be designed to enhance both user satisfaction as well as energy efficient.

2. Related work

This study focus on the advanced technology of the new intelligent LED lighting system which can be reduce the energy consumption and also suitable for the environment parameter by various way.

Gaspare Boscarino et al. presents a simulation environment and daylighting control strategy to achieve energy-efficient lighting while providing desired lighting levels at the target points. The lighting strategy is based on a self-tuning multivariable controller, which maintains the illuminance levels at user-defined set-points while improving the energy consumption due to artificial lighting. The simulation environment utilizes the so-called layered lighting design, which allows one to evaluate the performance of different control strategies. Furthermore, the environment can be used to validate the performance of a lighting control strategy, in quasi-real-time, and assess its potential energy savings. The above approach has not been investigated in prior literature and may thus be of interest in energy-aware automated lighting systems. A case study is presented for an open-plan office space exposed to variable natural light through windows and a set of individually addressable light emitting diode luminaries. [i] Jinsung Byun et al. Proposed system can be present the large amount of energy waste is introduced by not efficient use of the consumer electronic. The proposed system can be use wireless communication technology and multi sensors in order to control an LED light system according to the user satisfaction and energy efficiency. The proposed system of the new LED lighting system can automatically control and minimum light intensity value to improve both user satisfaction and energy efficiency [ii]. Qiang Gao et al. With the improvement of Internet of Things, innovation of Power over Ethernet can take enough power to LED lighting framework. Depending upon the detected data of the present brilliance and the quantity of persons in a room, the framework can naturally recognize and apply a predefined brightness [iii]. Jiande Wu et al. In the Power over Ethernet (PoE) framework, the conventional powered device (PD) with two sets design can just give power below 20W loads, which extraordinarily limits its applications in numerous territories. An advanced type of four sets design with an input current equalization capacity for the PoE framework is proposed framework enhance the power level, as well as accomplish the high conversion efficiency [iv].

F. Leccese et al. The proposed utilizes ZigBee-based remote device which enable more efficiency road light framework administration, because of a propelled interface and control design. It utilizes a sensor mix to control and ensure the proposed framework parameters the data is exchanged point by point utilizing ZigBee transmitters and beneficiaries and is sent to a control terminal used to check the condition of the road lights and to take proper measures if there should be an occurrence of failure [v]. A.

A. Siddiqui et al. The proposed framework presents client user energy efficient control design for road lights. The framework uses ZigBee technology to execute remote cross section system of road lights. The proposed framework involves LED lights and administration programming that offer remote checking and control of the lights [vi]. F. J. Bellido-Outeirino et al. The proposed framework focusses on the joining of Digital Addressable Lighting Interface (DALI) device in remote sensor systems. Since various producers for the most part manage one part of building robotization. The primary reason for these framework is to give the end consumer an economical completely framework in which home machines are control by remote sensor system [vii].

Tao Chen et al. The energy utilization issue in the mobile business has become crucial. For the supportable development of the mobile business. The point is to pick up a superior comprehension of energy utilization and distinguish key energy effectiveness research

issues in remote access systems. Grouping system energy saving technologies into the time, frequency, and spatial spaces, the fundamental arrangements in every area are described briefly [viii]. J. Byun et al. The proposed framework can be introduced Self-adjusting intelligent framework utilized for giving building control and energy saving administrations in structures. Our framework comprises of a gateway (self-adapting intelligent gateway) and a sensor (self-adjusting intelligent sensor). Thus, additionally propose an energy efficiency self-clustering sensor network (ESSN) and a node type indicator based routing (NTIR) convention that considers the necessities of WSNs, for example, system lifetime and framework resources administration [ix]. J. Han et al. The proposed framework can be described more proficient home energy administration framework to decrease power utilization in home territory. We consider the room effectively controllable with an IR remote control of a home appliance. The room has electrical plugs, a light, and a ZigBee center point. The ZigBee center point has an IR code learning work and teaches the IR remote control sign of a home machine associated with the electrical plug. The ZigBee center points in every room speak with the home server and report the force utilization data to the home server [x].

Y. Uhm et al. Traditional frameworks are only designed for power reduction of the consumer electronics. The propose framework can be available a force mindful LED light empowering agent with light sensors, movement sensors and system interfaces. The proposed framework can be available a versatile middleware encourages the learning system which breaks down the enlightenment and the client movement, and controls the LED lights just when clients exist around the gadgets [xi]. S. Matta et al. The propose framework can be available a framework with detailed configuration saving electrical energy by controlling the intensity of artificial light to a satisfactory level and getting utilization of the sunshine when possible with the best effort for energy saving. The framework utilizes Controller Area Network (CAN) as the media of correspondence with the sensors and the actuators. The framework is measured and can be extended to span large buildings [xii]. Ç. Atıcı et al. Customary street lighting frameworks are obsolete and ought to be supplanted with frameworks which can sense their surroundings. To comprehend these necessities, subjective analyses ought to be directed in a down to earth testbed, like our own. we first present the best in class arrangements in the writing. At that point, we portray the framework design of our testbed sent on a genuine road alongside the preparatory analyses [xiii].

S. Tompros et al. Given the energy waste issue in contemporary family units and the subsequent requirement for ideal energy utilize, this article exhibits a novel system engineering that is generically appropriate on local apparatuses, such as white goods, and varying media and correspondence hardware, and is fit for performing ongoing administration of their vitality utilization [xiv]. T. J Park et al. lighting control frameworks give different advantages in building administration, and Building Automation and Control Network (BACnet) is a universal standard information correspondence convention for building mechanization and control systems. We present a reference model for BACnet-based lighting control frameworks and assess its execution utilizing an exploratory model [xv]. G. W. Denardin et al. One of the significant difficulties right now is the change of the present road lighting framework. These frameworks are viewed as obsolete due the absence of correspondence abilities, not permitting framework input. This work intends to add correspondence capacities to the frameworks as of now being used, through the reconciliation of a ZigBee perfect handset to the photoelectric transfer used to turn the HPS lights on/off. This change will transform every gadget into a hub of an extensive remote system over the city [xvi].

3. System Design

The system can be used two sensors, as shown in figure 1 and 2, such as PIR sensor and Illumination sensor. Passive infrared sensor can be work when human interaction can be introduced in the room. Illumination sensor can be adjusted the light intensity value according to room outside external environment Means it can be adjust room internal light intensity illumination according to external environment brightness. By using these two sensors the rooms light intensity can be automatically adjust by introducing human interaction and external environment condition.

The system design based on Arduino controller is used intelligent household LED Lighting system and various sensor used in this system such as PIR sensor, LDR sensor. These all the sensor analog output is an interface to a controller by using analog to digital converter and signal conditioning circuit. As shown in fig 2. By gathering all the information from sensors the LED lighting system can be controlled the room LED light intensity and also controlled ON-OFF LED lights. And all the output of this sensor showed in PC through RS232 serial communication in visual basic software. The PIR and LDR sensor are interfaced to a controller by using pin configuration interface. Zigbee module is used for transmitting and receives the signal from PIR and LDR sensor. Zigbee module can be connected to central control such as the computer by using USB to serial cable such as RS-232 cable. Both Zigbee module can be work as the transmitter as well as receiver module.

The working of this proposed system such as it can be used PIR sensor and PIR sensor can be work when human or any animal interaction can be introduced in the room. When human activities can be introduced in the room then the PIR sensor module output become high level and LED light should be ON. When there is no human interaction can be introduced in the room then the PIR sensor module output becomes low level and LED light should be OFF. The working of LDR sensor such as LDR sensor can adjust the LED light intensity according to room light intensity. When room sunlight intensity is low then LDR sensor can adjust the LED light intensity and increase the LED light intensity. When room sunlight intensity is high then LDR sensor can adjust the LED light intensity and decrease the LED light intensity.

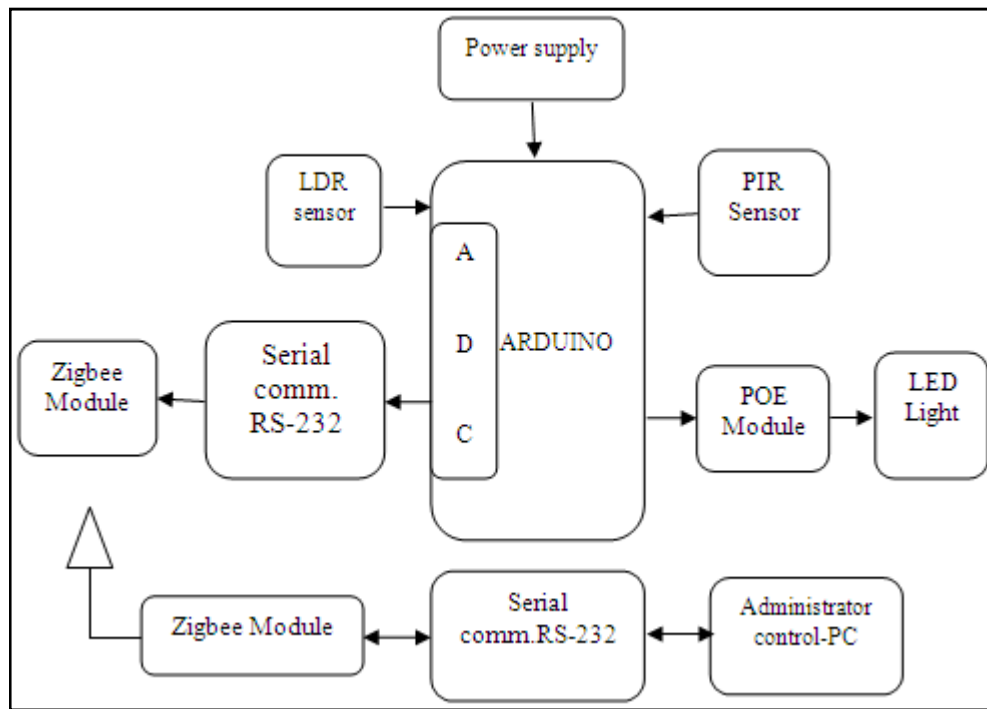


Figure 1: Block diagram of the proposed system

When both sensors such as LDR and PIR sensor can be satisfied the given condition then LED light should be ON, otherwise LED light should be OFF. Both sensor conditions should be given below,

Condition -1] When a person is available and light intensity high then LED bulb is OFF and according to room condition LDR sensor adjust a LED light intensity.

Condition -2] When a person is available and light intensity low then LED bulb is ON and according to room condition LDR sensor adjust a LED light intensity.

Condition -3] When a person is not available and light intensity high then LED bulb is OFF and according to room condition LDR sensor adjust a LED light intensity.

Condition -4] When a person is not available and light intensity low then LED bulb is OFF and according to room condition LDR sensor adjust a LED light intensity.

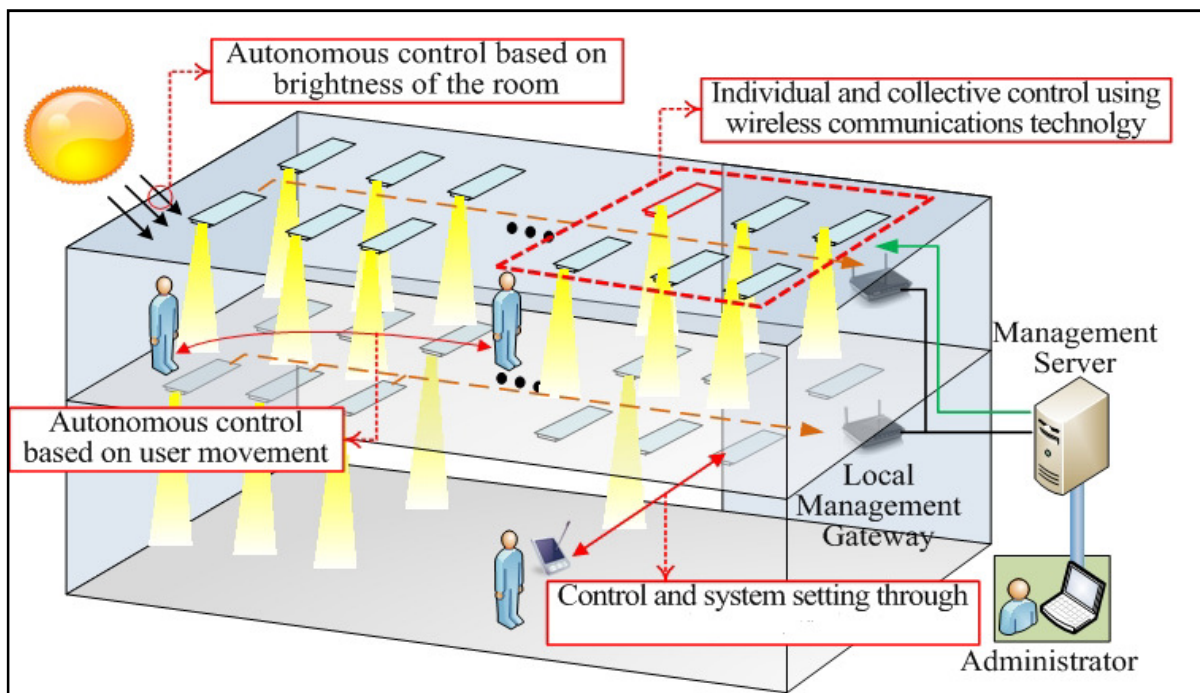


Figure 2: Overview of the proposed system

3.1. ARDUINO Controller

The Arduino Ethernet shield with PoE Module is based on the Wiznet W5100 ethernet chip. Thus Wiznet W5100 provides a network stack capable of both transmission control protocol (TCP) and user/ universal datagram protocol (UDP). TCP and UDP can support less than four simultaneous socket connections. In the TCP protocol, a message can be transferred through the internet from one computer to another computer. Thus the TCP is suitable for application that required high reliability and transmission time is relatively less critical. But the speed of TCP is slow as compared to the UDP. TCP also provide the reliability such as, data can be sent in any format then the same format can receive the data. TCP can provide header size up to 20bytes. In the UDP protocol, a message can be transferred through the wireless by using load on a packet. UDP is suitable for application that needs fast, efficient transmission such as a game. UDP is Useful when servers can be entered that answer small queries from a huge number of clients. UDP is faster as compared to TCP because there is no error checking for a packet. Thus the UDP not provides reliability such as, there is no guarantee that the message or packets sent would reach at all. UDP header size is 8 bytes. When proposed system can be designed by using any processor it cannot be used PoE module because of this reason when it can be connected any sensor it can be required external power supply ,this processor cannot provide any internal power supply but in these proposed system can be used a PoE module, when PoE module can be connected to the Ethernet board and can be connected any sensor then it cannot be required any external power supply because PoE can provide the internal power supply of any sensor module. Any other controller cannot support PoE module but only Arduino controller can be supported PoE module. Hence by using the PoE module power consumption can be reduced.

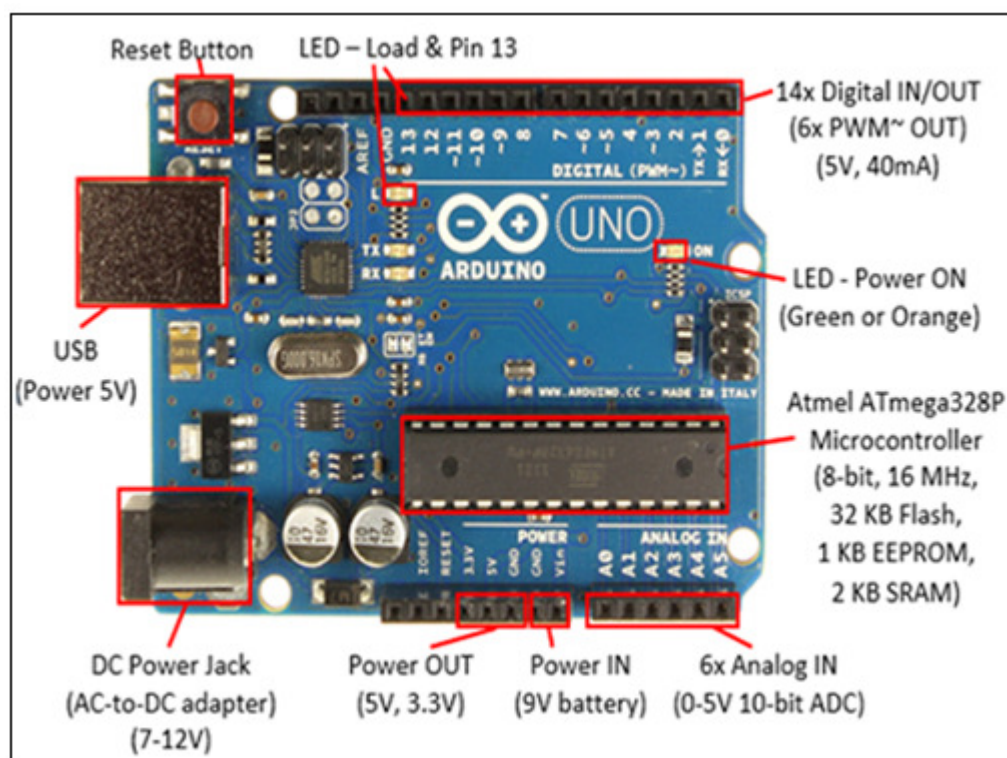


Figure 3: ARDUINO Controller Board

3.2. Zigbee Module

Many years ago, when Bluetooth technology was introduced, Bluetooth technology can be provided the data rate up to 1Mbps, range is 10 meter, it can be consume very less power, it can be provided security such 64 and 128 bit encryption, operating frequency 2.4 GHz But it has two limitation such as very small network topology and high complexity. Then another technology can be introduced such as Wi-Fi, Wi-Fi can be provided 11Mbps and 54 Mbps data rate, range is 100 meter, it can be provided point to hub network topology, operating frequency is 2.4 GHz and 5GHz, high security but it has some limitation such as high complexity, high power consumption. The limitation Bluetooth and Wi-Fi device can be overcome by introducing zigbee device. Zigbee provides network topology such as peer to peer, star and mesh. Zigbee range is 100 meter, operating frequency is 2.4 GHz, low complexity, less power consumption device, zigbee provide high security such as 128 AES (Advanced encryption standard) plus application layer security but one limitation can be introduced in zigbee as compared to Wi-Fi and Bluetooth such it can be provided 20Kbps, 40Kbps, 250kbps data range which is less than Bluetooth and Wi-Fi. Zigbee has low cost and low power for energy efficient and cost effective intelligent devices.



Figure 4: Zigbee Module

Parameter	Wi-Fi (802.11)	Bluetooth	Zigbee
Data Range	11 & 54 Mbps	1Mbps	20, 40, 250Kbps
Range	100 Meters	10 Meters	100 Meters
Network Topology	Point to Hub	Very small network	Peer to Peer, Star & Mesh
Operating Frequency	2.4, 5GHz	2.4GHz	2.4GHz
Complexity	High	High	Low
Power Consumption	High	Medium	Very Low
Security	High	Medium	128 AES plus application layer security

Table 1: Comparison of Wi-fi, Bluetooth and ZigBee

3.3. LDR Sensor

Illumination sensor can adjust the light intensity value according to room inside internal environment Means it can adjust room internal light intensity illumination according to room internal environment brightness. When internal environment brightness is low then the illumination sensor resistance is very small and it can increase the room light intensity illumination value. When internal environment brightness is high then the illumination sensor resistance is very high then it can be automatically decrease the room light intensity illumination value.

Illumination sensor can be collects the information of room light intensity through the Ethernet cable and send an electrical signal to the control system. Then the control system can be collect the information and it can analyze the collected information and sent the instruction to the power over Ethernet (PoE) controller. According to the collected information LED lighting system of PoE controller can be automatically adjust the brightness of the room.

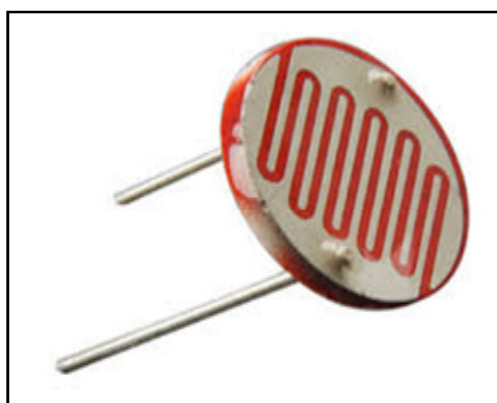


Figure 5: LDR Sensor

3.4. PIR Sensor

The passive infrared sensor can be work when human or any animal interaction can be introduced in the room. When human activities can be introduced in the room then the PIR sensor module output become high level and LED light should be ON. When there is no human interaction can be introduced in the room then the PIR sensor module output becomes low level and LED light should be OFF.

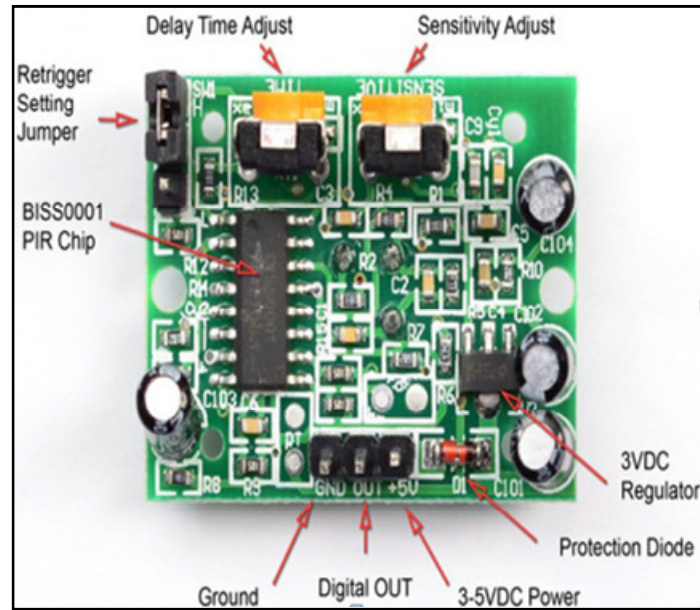


Figure 6: PIR Sensor

4. Algorithm

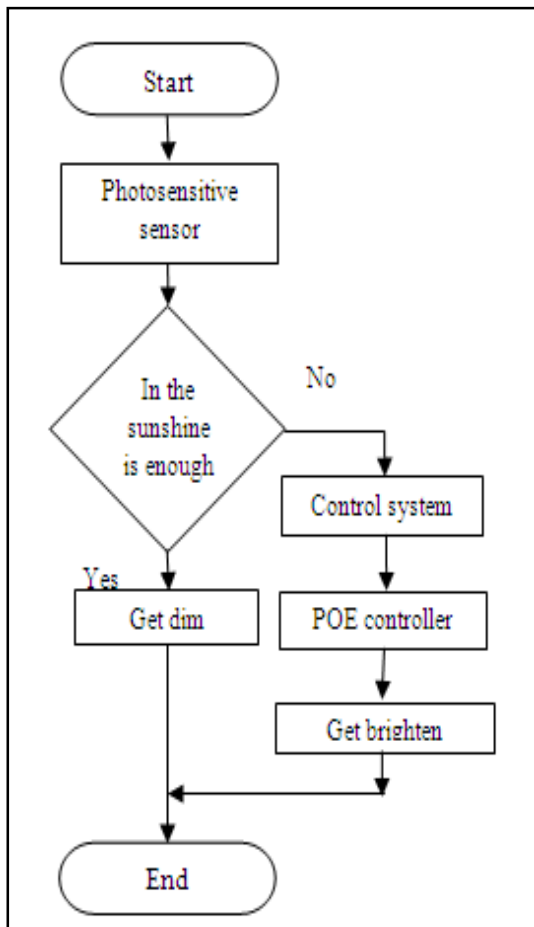


Figure 7: Brightness control flow chart (LDR Sensor)

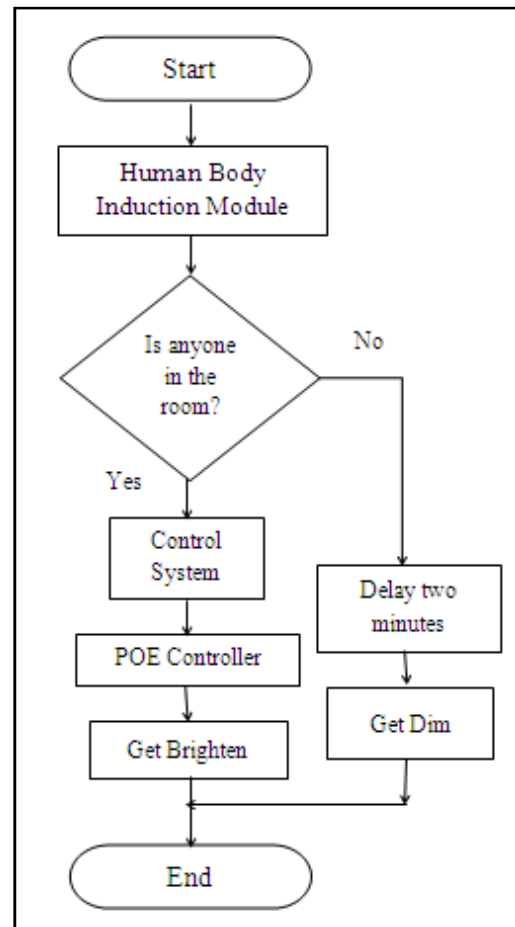


Figure 8: Switch control flow chart (PIR Sensor)

5. Results

CONDITION	CONDITION	LED Bulb
PIR Sensor	LDR Sensor	
Person is available	Light intensity high	OFF
Person is available	Light intensity low	ON
Person is not available	Light intensity low	OFF
Person is not available	Light intensity high	OFF

Table 2: Result Table

Condition -1] When person is available and light intensity high then LED bulb is OFF and according to room condition LDR sensor adjust a LED light intensity.

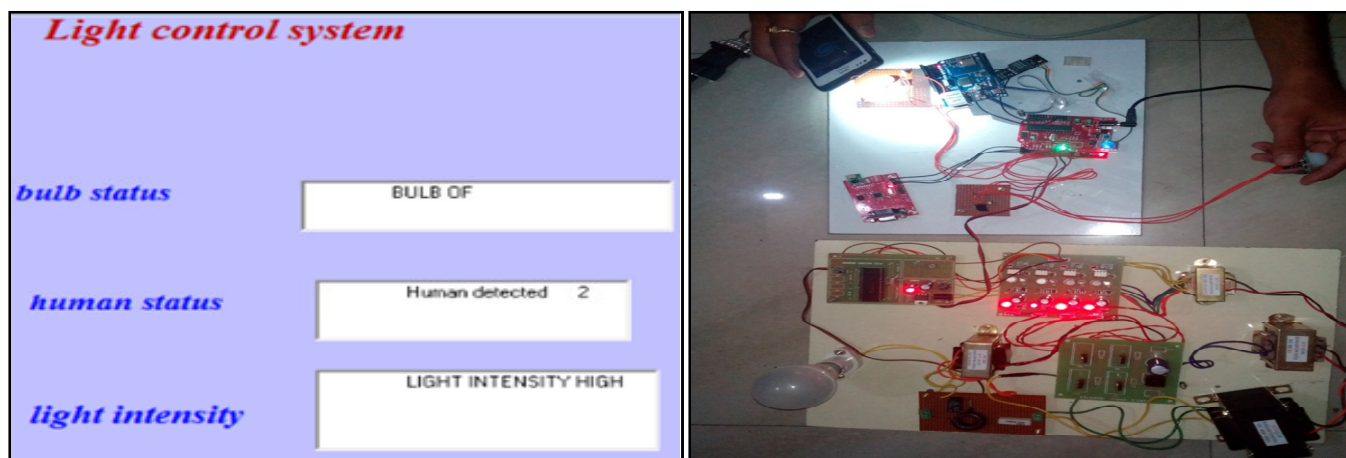


Figure 9: Software and Hardware Result of condition-1

Condition -2] When person is available and light intensity low then LED bulb is ON and according to room condition LDR sensor adjust a LED light intensity.



Figure 10: Software and Hardware Result of condition-2

Condition -3] When person is not available and light intensity high then LED bulb is OFF and according to room condition LDR sensor adjust a LED light intensity.

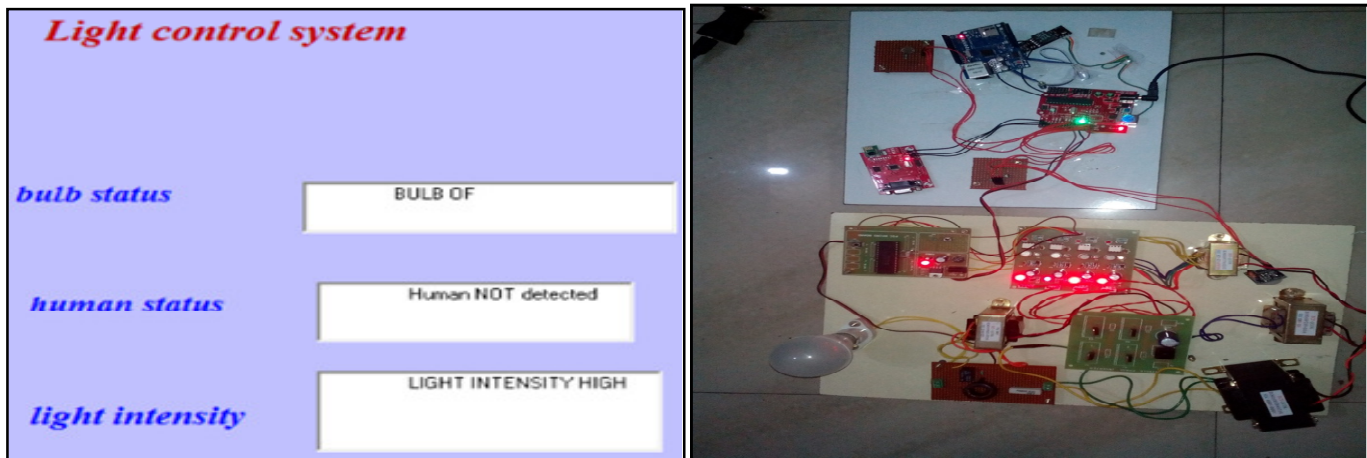


Figure 11: Software and Hardware Result of condition-3

Condition -4] When person is not available and light intensity low then LED bulb is OFF and according to room condition LDR sensor adjust a LED light intensity.

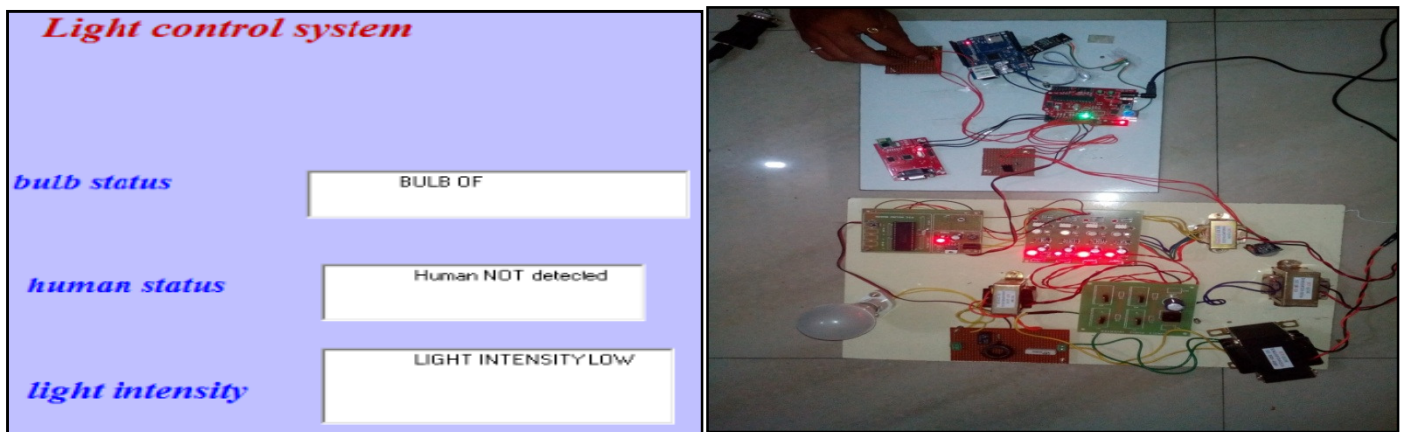


Figure 12: Software and Hardware Result of condition-4

6. Advantages

1. Proposed system provides automatically control based on brightness of the room.
2. Proposed system can be Design to maximum used of an LED lights.
3. Proposed system can be Design to have the communication capability and Collective control using a wireless technology.
4. Reduction in power consumption and Saves energy.
5. Proposed system provides Autonomous control based on situation awareness and user movement
6. Proposed framework can be Design to improve both client fulfillment and Energy efficient.
7. Proposed system Improves life of devices.

7. Conclusion

Now a day saving energy has become one of the most vital points. The conventional lighting system can be acquired around 20% to 25% of the overall word energy consumption. Thus a lot of studies related to the energy saving no product can be entered in both user comfort and energy productive than the conventional lighting system cannot be successfully suitable to the office building and home. Then the recommended system can be used a wireless communication technology and various sensors which can control the LED lighting system Depending on the understanding knowledge of the current illumination and the whole persons in a room, the system can automatically distinguish and utilize a predefined brightness. Therefore, it overcomes the limitations of a traditional light control system. The proposed system of new LED lighting system can be automatically control and minimum light intensity value to improve both user comfort and energy productivity. The proposed new LED lighting system can be reduced the overall power consumption.

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